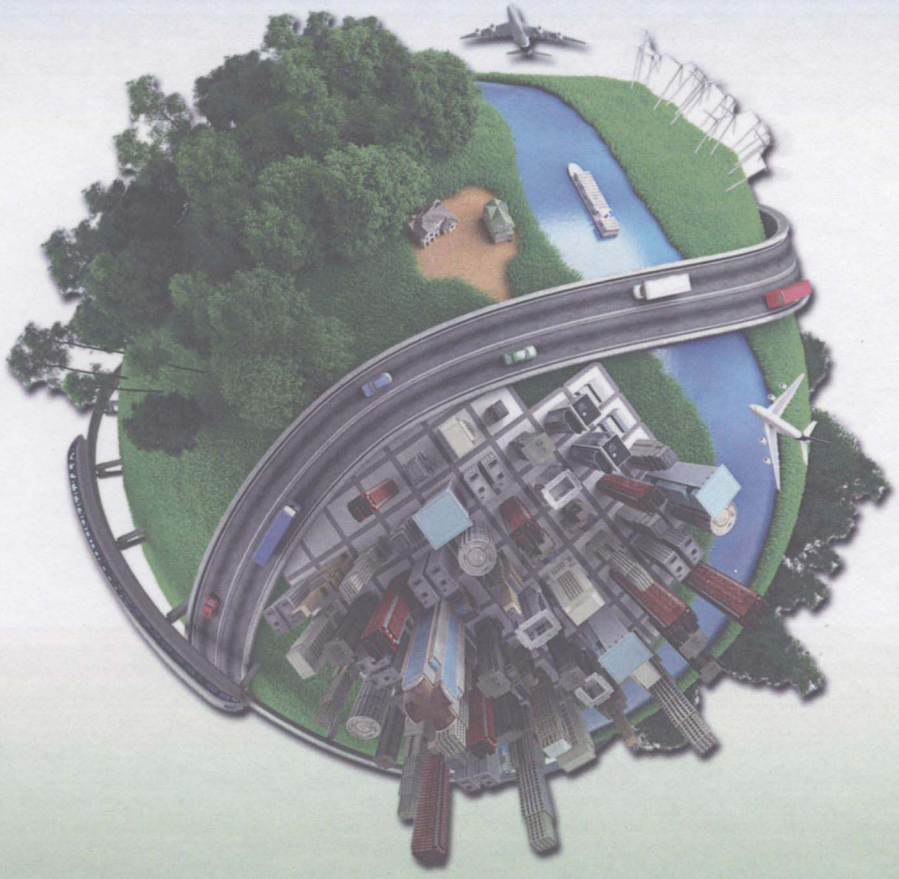
ENERGY EFFICIENCY in the URBAN ENVIRONMENT



Heba Allah Essam E. Khalil
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CRC Press
Taylor & Francis Group

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed on acid-free paper
Version Date: 20141216

International Standard Book Number-13: 978-1-4822-5063-3 (Hardback)

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
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To our students who deserve to know.

To our family who supported us to know.

To my mother who always urged me to know.

To my sons, may you enjoy a better environment.

Preface

Energy crisis, urbanisation and climate change are three global challenges of the twenty-first century. They are closely interrelated either by causal effect (where one causes the other) or by three separate phenomena that have parallel impacts.

This book is an attempt to study these challenges worldwide as well as to deal with or combat them in the Middle East – with a special focus on Egypt. In this quest, the authors address these issues from multiple perspectives, disciplines and scales. The first four chapters of this book address the macroscale of urbanism. First, the macroscale of cities is studied from the perspective of city dwellers' quality of life. Second, achieving energy efficiency through urban planning is investigated as a tool for improving city energy performance. Third, the energy efficiency performance of cities is studied by measuring various related indices and their indicators; this is tied to which sustainable urbanism principles these cities follow. Fourth, the author analyses how informal areas – as the most predominant feature of urbanisation in developing countries – achieve sustainable development as a different approach to sustainable urbanism. Case studies are presented and analysed in each chapter; these studies mainly use Egypt as an example for arid zones, developing countries and high rates of urbanisation and include Africa's biggest mega city: Cairo.

With its location and urban characteristics, Egypt represents a true model of the three challenges that the book addresses. It is continuously urbanising with its rural settlements expanding to become cities and its cities growing and encroaching on surrounding agricultural land. Egypt has scarce water resources because it is 95% arid. It is also highly susceptible to climate change, which has been clearly monitored in the past decade. Egypt's Nile Delta and north coast are among the most vulnerable risk zones worldwide. Finally, Egypt is witnessing a daily growing energy crisis with high consumption rates, no energy efficiency measures and continuously diminishing potential oil reserves. These factors make it crucial for Egypt to address these issues and to formulate and implement an energy efficiency policy to help mitigate the effects of urbanisation and climate change and to improve quality of life through energy-efficient urbanism.

The second part of the book addresses the challenges through the microscale of buildings and the perspective of ensuring indoor air quality within the boundaries of energy efficiency. Energy performance of buildings should include a general framework for the calculation of energy performance and building categories together with thermal characteristics of building, air-conditioning, ventilation, lighting and appliances aspects. These include the contribution of active solar systems to domestic water

heating based on renewable energy sources, Combined Power and Heat (CPH) production and district cooling systems. The book demonstrates the importance of incorporating an energy performance directive as a standard in our region; such a goal will aid energy savings in large buildings and set regulations for energy-efficient designs that are based on standard calculation methods. Energy standards would be largely based on international standards and appropriately modified to suit local practices. The target is to develop standardised tools for the calculation of the energy performance of buildings, with defined system boundaries for the different building categories and for different cooling/heating systems, and to develop a common procedure for obtaining an 'energy performance certificate'. This book attempts to provide transparent information regarding output data (reference values, benchmarks, etc.) and to define comparable energy-related key values (kWh/m^2, kWh per person, kWh per apartment, kWh per produced unit etc.). Proposals to develop a common procedure for an energy performance certificate and CO_2 emissions are also given.

Acknowledgements

The authors thank their colleagues and collaborators for the useful discussions that led to the elaboration of this book. The authors express their special thanks and gratitude to their family legends, the late Dr. Khalil Hassan Khalil and late Dr. Galal Shawki of Cairo University, for their teaching and mentoring. The authors extend their gratitude to Dr. Ahmad Khalil for his extensive discussions and technical support. Thanks are also due to Eng. Hala Assaf for her everlasting support to Dr. Heba Allah Essam Khalil.

Heba Khalil extends her gratitude to her mentor, Dr. Sahar Attia, for her continuous encouragement in the publication of this book. Thanks are also due to her husband, Eng. Abdel Monem Abul Fadl; without his support, this book would not have been possible.

The authors also thank the publishers for their advice and support throughout the publishing process.

Finally, the authors thank one and all who inspired this work by posing questions or probing existing problems that required new research to realise new concepts and solutions.

About the Authors

Heba Allah Essam El-Din Khalil holds a BSc (2000) in architectural engineering, MSc (2003) in urban planning and a PhD (2007) in architectural engineering from Cairo University. Currently, she is an associate professor in the Department of Architectural Engineering, Faculty of Engineering, Cairo University, with 15 years of academic experience. She has pursued scientific research in various fields, including community development, participatory evaluation, informal areas development, energy-efficient strategies in urban planning, sustainable urbanism, green rating systems, affordable housing, quality of life and strategic planning. She has supervised more than 25 MSc and PhD theses in related research domains. She has participated in several national and international conferences, workshops and training courses. She is currently participating in a number of joint research projects with Cairo University and other international research institutes. She is a member of the informal hub of the Habitat Universities initiative UN-Habitat.

Dr. Khalil has additional professional experience as an architect and as an urban planner on various projects. She worked with international agencies as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in participatory development, including facilitation and evaluation. She has worked for UN-Habitat in sustainable urban development strategy in Arab countries and in strategic planning for cities and city regions in Egypt. She has designed a number of private and public buildings. She was a member of the winning team of Khedive's Cairo rehabilitation competition. This multidisciplinary experience has supported her academic competence and sense of the real surrounding world.

Essam E. Khalil holds a BS (1971) and MS (1973) in mechanical engineering from Cairo University, and DIC (1976) and PhD (1977) from Imperial College of Science and Technology, London University, UK. Currently, he is a professor of mechanical engineering at Cairo University (since June 1988). He has more than 44 years of experience in design and simulation of combustion chambers for terrestrial and aerospace applications. He has published more than 600 papers in journals and conference proceedings as well as 12 books on combustion, energy and indoor air quality control. Dr. Khalil is a fellow of ASME, fellow of ASHRAE, convenor of ISO TC205WG2 on energy efficiency and ISO TC163 WG4, and also a member of ISO TC163. He is an ASHRAE distinguished lecturer. He is a recipient of the Outstanding Achievement in Science Award, Cairo University, 2005, 2006 and 2008; best Paper Award from AIAA Terrestrial Energy TC, 2005;

ASME George Westinghouse Award, 2009; ASME James Harry Potter Gold Medal 2012; and Distinguished Service Award ASHRAE and Sustained Services Award AIAA.

He is the editor of *Energy & Buildings, CFD Letters, and International Journal of Reacting Systems* and also an associate editor of *Energy Technology and Policy.*

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